

Experimental Study on Upgrading by Flotation of Inferior Coal from Guo Hui Coal Preparation Plant in Inner Mongolia

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Abstract: The content of high ash fine slime in raw coal of Shiguai area in Inner Mongolia is high, the load of flotation system of coal preparation plant is heavy and the flotation clean coal ash is difficult to meet the local standard lower than 15.00% thus resulting in a serious waste of slime resources. This paper took the primary slime of Guo Hui Coal Preparation Plant in Baotou, Inner Mongolia as the research object, small screening test of coal slime, batch flotation test, regressive release flotation test and flotation column test were undertaken. The results showed that when the required flotation clean coal ash was 15.00%, the theoretical clean coal yield was 24.66%, the tailing ash was 53.73%, the combustible recovery was 37.95% and the slurry floatability rank was determined to be extremely difficult to float; primary flotation clean coal ash of flotation machine or flotation column did not meet the requirement; flotation concentrate obtained by primary roughing and secondary concentration of flotation column can meet the requirement and the clean coal ash was 13.67% while the yield was 33.45%. The results can be used as reference for field production.

Introduction

With the deterioration of the coalfield geological condition, the content of high ash fine slime in coal of Shiguai area in Inner Mongolia has increased, the load of flotation system of coal preparation plant has been heavier and the flotation clean coal ash has been difficult to meet the local standard lower than 15.00% thus resulting in a serious waste of slime resources. In order to solve this problem, this paper took the primary slime of Guo Hui Coal Preparation Plant in Baotou, Inner Mongolia as the research object, explored the optimal flotation scheme under certain clean coal ash standard and provided the basis for technological transformation of the coal preparation plant.

Coal sample analysis

According to GB / T 477-2008 "Coal Screening Test Method", small screening test of the flotation feed was conducted and the test results are shown in Table 1.

Table1 Sieving test results of coal slime

Size/mm	Mass/g	Yield/%	Ash /%	Accumulation	
				$\gamma/\%$	$A_d/\%$
+0.5	18.64	9.66	47.31	9.66	47.31
0.5-0.25	25.76	13.35	42.09	23.01	44.28
0.25-0.125	31.42	16.28	42.41	39.28	43.51
0.125-0.074	17.75	9.20	42.74	48.48	43.36
0.074-0.045	34.36	17.80	44.02	66.28	43.54
-0.045	65.07	33.72	48.79	100.00	45.31
合计	193.00	100.00	45.31		

As shown in Table 1, the total ash was 45.31%. According to the standard classification of coal ash, the primary coal slime ash was high. Its dominant size fraction was -0.045mm, the yield was 33.72% and the ash content was 48.79%, followed by 0.074 ~ 0.045mm size fraction, the yield was 17.80% and the ash content was 44.02%; for 0.25 ~ 0.125mm size fraction, the yield was 16.28% and the ash content was 42.41%. The ash content of each size fraction was evenly between 42.09% ~ 48.79% which indicated that the ash content of primary coal slime was high. Yield of +0.5 mm size fraction was 9.66%, indicating the presence of "running coarser particle" phenomenon.

According to GB / T478-2008 "Coal Float-Sink Test Method", float-sink test was conducted. The results are shown in Table 2. The floats cumulative curve and sediments accumulated curve drawn from Table 2 are shown in Fig.1.

Table2 Float-sink test results of primary coal slime

Density /g·cm ⁻³	Mass/g	Yield/%	Ash/%	Accumulated floats		Accumulated sediments	
				Yield/%	Ash/%	Yield/%	Ash %
<1.3	3.20	5.34	4.58	5.34	4.58	100.00	44.12
1.3~1.4	8.73	14.58	8.80	19.93	7.67	94.66	46.35
1.4~1.5	6.76	11.29	16.70	31.22	10.94	80.07	53.19
1.5~1.6	5.83	9.74	25.18	40.96	14.32	68.78	59.18
1.6~1.8	8.46	14.13	35.62	55.09	19.79	59.04	64.78
>1.8	26.89	44.91	73.96	100.00	44.12	44.91	73.96
总计	59.87	100.00	44.12				

As can be seen from Table 2, the yield of intermediate density fraction 1.4~1.8 g/cm³ was 35.16%; - 1.5 g/cm³ cumulative yield was 31.22% with ash content of 10.94%; the yield of leading density +1.8 g/cm³ was 44.91% while the ash content was 73.96% .

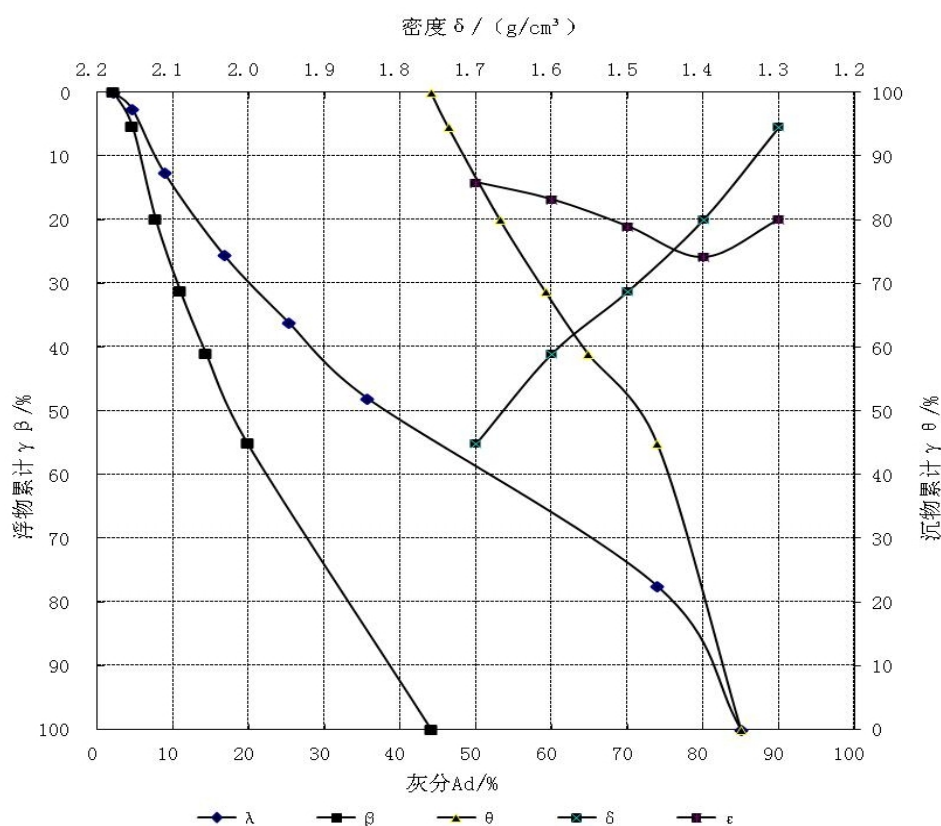


Fig.1 Washability curve of coal slime

As can be seen from Fig.1, when the ash content was 15.00%, theoretical yield of clean coal was 42.71%.

Experimental research of coal slime floatability

Coal slime flotation. Coal slime floatability test conditions were as follows: XFD flotation machine, kerosene as collector, octanol as frother, pulp density 60 g / L, flotation tank volume 1.5 L, impeller speed 1800 r / min, aeration rate 0.25 m³ / min, the pulp pre-stirring time 2 min, the collector contact time 2 min, frother contact time 30 s, scraping time 3 min. According to GB / T 4757-2001 “Coal Slime Laboratory Flotation Test Method”, flotation exploring tests of coal slime were conducted. Collector and frother ratio was 6:1, the test results are shown in Table 3.

Table3 Test results of reagent system

Collector / (g·t ⁻¹)	Frother / (g·t ⁻¹)	Clean coal		Tailing		Flotation erfect Index/%
		Yield/%	Ash/%	Yield/%	Ash/%	
500	83	45.24	23.60	54.76	63.55	38.74
1000	167	61.43	27.78	38.57	77.27	42.21
1600	267	62.38	27.31	37.62	73.01	44.06
2000	333	66.78	28.64	33.22	77.70	43.58
2400	400	65.60	30.78	34.40	73.52	37.11

Table 3 shows that the minimum ash content of exploring flotation tests was 23.60% with the yield was 45.24%, and corresponding collector and frother dosage was 500g/t and 83g/t, respectively. Under the conditions of fixed amount of frother and collector, with the reduction of the reagent, ash and coal yield tended to decrease overall. The ash content required by coal preparation

plant is less than 15.00%, but the coal ash in the flotation test can not meet the requirements.

According to the results of coal preparation plant production as well as high ash characteristics, the primary flotation was difficult to meet the requirement of coal ash. Therefore, the flotation column tests were conducted to obtain qualified clean coal.

Release flotation test. The test collector dosage was 500g / t and frother dosage was 83 g / t. The results are shown in Fig.2.

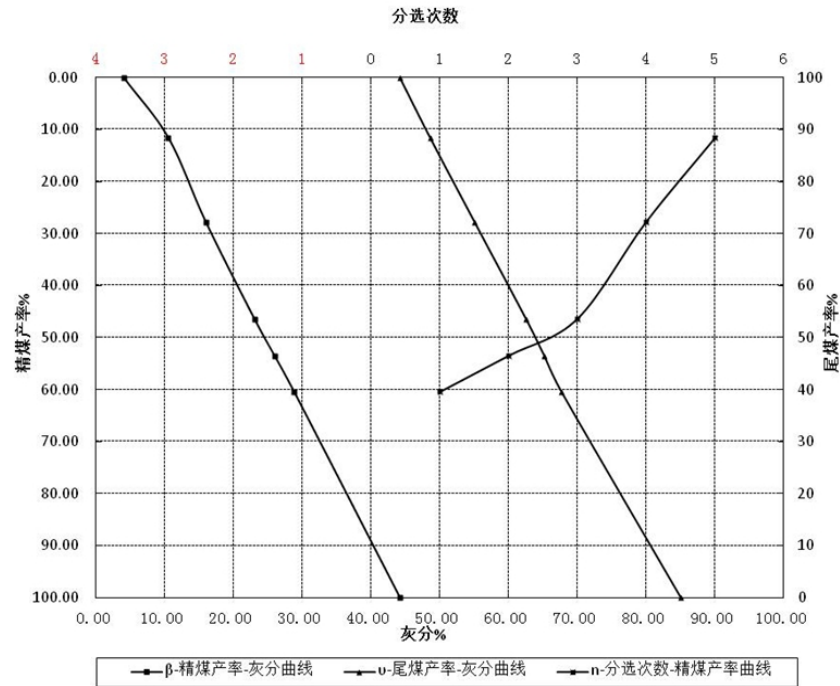


Fig. 2 Curve of stepped releasing test

Theoretical slime flotation index can be determined by releasing test. As shown in Fig.2, when the requirement of clean coal ash was 12.00%, the theoretical clean coal yield was 15.82%, and tailing ash was 50.31%. When the requirement of clean coal ash was 15.00%, the theoretical clean coal yield was 24.66%, and tailing ash was 53.73%. Referring to MT/T259-1991 "Coal Floatability Assessment Methods", the floatability of coal slime can be evaluated based on the results of flotation test when the clean coal ash was 15.00% .

When flotation concentrate ash content was 15.00%, the flotation concentrate yield was 24.66%. The flotation feed ash was 44.77%, so the coal flotation combustible recovery was

$$e^g = \frac{g_j(100 - A_{d,j})}{100 - A_{d,y}} \times 100\% = \frac{24.66 \times (100 - 15.00)}{(100 - 44.77)} \times 100\% = 37.95\%$$

According to this result, the floatability rank was extremely difficult to float.

Coal slime flotation tests by flotation column. According to the reagent flotation tests, coal slime was separated by flotation column. Separation exploring tests was carried out by cyclone-microbubble flotation column, with 500g/t collector agent, 83 g/t frother dosage , 20 cm foam layer and 60 g/L feed concentration.

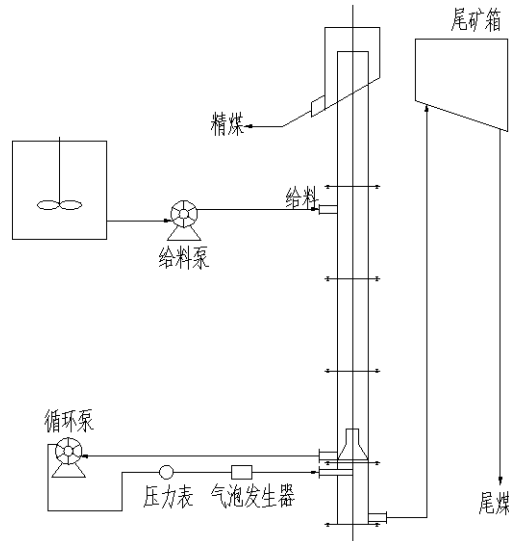


Fig.3 The flotation column experiment system

The reagent flotation test results were shown in table 4.

Table4 Separation test results by flotation column

Pressure /MPa	Clean coal		Tailing		Flotation Perfect Index/%
	Yield/%	Ash/%	Yield/%	Ash/%	
0.12	48.70	26.13	51.30	62.46	36.70
0.14	48.56	30.32	51.44	58.41	28.38
0.16	49.16	24.18	50.84	64.68	40.93
0.18	56.18	28.20	43.82	66.01	37.65

As shown in Table 4, similar to the results of stepped releasing test, ash content of clean coal separated by flotation column did not meet the requirement and the lowest point of clean coal ash was 24.18% while the yield was 49.16%. In order to obtain qualified products, the secondary concentration of flotation column was performed on the flotation concentrate obtained by primary roughing. Furthermore, considering the yield of the clean coal by secondary concentration, the clean coal ash by primary roughing should not be too high and the yield of it should not be too low.

According to the principle of improving clean coal yield by primary roughing and clean coal ash by secondary concentration, the primary roughing test was carried out by flotation column with the conditions as follows: 500 g/t collector agent, 83g/t frother dosage, 20cm foam layer, 60g/L feed concentration and 0.16MPa pressure of circle pump. The clean coal of it would be the feed for the secondary concentration test after being filtered and dried. The feed ash and yield for the secondary concentration test was 24.18% and 49.16%, respectively. The ash content of tailings was 64.68% and the yield of it was 50.84%. The secondary concentration test was carried out with the condition as follows: 50g/t collector agent, 300 g/t frother dosage , 20 cm foam layer and 60 g/L feed concentration considering the residue of flotation reagent in the dried roughing concentrate. The secondary concentration test was undertaken to explore the effect of circle pump pressure on the quality of clean coal.

Table5 Selected test results of coal slime by flotation column

Pressure/MPa	Clean coal			Middling			Flotation Perfect Index /%
	Particle Size in raw coal /%	Particle Size In this Product /%	Ash /%	Particle Size In this Product /%	Particle Size in raw coal /%	Ash /%	
0.12	24.71	50.26	12.60	24.45	49.74	35.89	31.75
0.14	33.45	68.05	13.67	15.71	31.95	46.58	39.03
0.16	46.18	93.93	21.43	2.98	6.07	66.85	14.13

It can be seen from Table 5 that the clean coal ash was $13.67\% < 15\%$, meeting the requirement of the clean coal ash, when the pressure of circle pump was 0.14MPa. The yield of clean coal was 33.45%, after secondary concentration of flotation column.

Conclusion

- (1) The ash content of primary coal slime was 45.31% and it belonged to high ash coal slime; the main size fraction was -0.045mm, and the yield was 48.79%. From the results of regressive release flotation test, the slurry floatability rank was determined to be extremely difficult to float.
- (2) The flotation test indicated that primary flotation clean coal ash of flotation machine or flotation column did not meet the requirement. However, the performance of flotation column was better than that of flotation machine.
- (3) Flotation concentrate obtained by primary roughing and secondary concentration of flotation column can meet the requirement. The clean coal ash was 13.67% while the yield was 33.45%, the middling ash was 46.58% while the yield was 15.71% and the tailing ash was 64.68% while the yield was 50.84%.

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